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Final

Supplemental Field Investigation Plan Landfill B and The Burning Grounds St. Juliens Creek Annex Site Chesapeake, Virginia

Prepared for

Department of the Navy

Atlantic Division

Naval Facilities Engineering Command

Norfolk, Virginia

Contract No. N62470-95-D-6007
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Final

Supplemental Field Investigation Plan
Landfill B (Site 2) and The Burning Grounds (Site 5)

St. Juliens Creek Annex Site
Chesapeake, Virginia

Contract Task Order 0028

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Department of the Navy
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Under the

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ABBREVIATIONS AND ACRONYMS

BERA .... Baseline Ecological Risk Assessment
bgs .... below ground surface
BTAG .... Biological Technical Assistance Group

COPC .... chemical of potential concern
CTO .... Contract Task Order

DPT .... direct push technology

EPA .... United States Environmental Protection Agency

FS .... feasibility study

HHRA .... Human Health Risk Assessment

PCBs .... polychlorinated biphenyls
PVC .... polyvinyl chloride

RI .... remedial investigation

SVOC .... semivolatile organic compounds

TAL .... target analyte list
TCE .... trichloroethene
TCL .... target compound list
TOC .... total organic carbon

TNT .... trinitromene toluene

VDEQ .... Virginia Department of Environmental Quality
VOC .... volatile organic compounds

1. Background

CDM Federal has been conducting remedial investigation/feasibility studies (RI/FS) at four sites at St. Juliens Creek Annex for the Navy. The work is being conducted under two contract task orders (CTOs), each with two sites. CTO 027 includes Landfill C and Landfill D, and CTO 028 includes Landfill B and the Burning Grounds. In February 1998, CDM Federal submitted draft remedial investigation reports for all the sites. The reports included the results of the remedial investigation and the Human Health Risk Assessments (HHRA). Baseline Ecological Risk Assessments (BERAs) are also being prepared and will be submitted as separate documents.

During the preparation of the draft RI reports and BERAs, as well as during discussions with the Biological Technical Assistance Group (BTAG), Environmental Protection Agency Region III (EPA), and Virginia Department of Environmental Quality (VDEQ), it became apparent that additional data were necessary to fully define the extent of contamination. At the request of the Navy, CDM Federal prepared this Supplemental Field Investigation Plan to acquire the additional data.

The purpose of this Supplemental Field Investigation Plan is to present the data needs that have been identified to date for Landfill B and the Burning Grounds. Data needs for both sites are discussed in this plan. The "Final Landfill B and the Burning Grounds Work Plan, dated May 1997" should be referenced for pertinent information regarding this Supplemental Site Investigation Plan. The data needs identified for the sites investigated under CTO 27 are addressed in a separate document. This plan does not address the background investigation, which may be conducted at the same time as this supplemental investigation.

Landfill B

Landfill B (Site 2) was an unlined landfill at the corner of Saint Juliens Drive and Craddock Street in the southwestern section of the facility (Figure 3-1). The landfill began operations in 1921 until sometime after 1947. Refuse was burned onsite and used to fill in an adjacent swampy area. In 1942, an incinerator was installed and took the place of the open burning, and the landfill was closed sometime after 1947. The area has since become a swampy area that is covered with brush, trees, and grass, and is currently being used for storage of heavy equipment and machinery.

Refuse disposed of at Landfill B comprises garbage, acids, and waste ordnance. Total volumes before burning are estimated at 950,000 cubic feet, half of which was disposed of prior to 1942. Blast grit from ship overhaul and repair operations was also dumped at this location, although the exact year is unknown.

Burning Grounds

The Burning Grounds (Site 5) is located off of Craddock Street in the northern part of the facility (Figure 3-2). The site currently consists of an open field with areas overgrown with high reeds. The exact start and closure dates of the Burning Grounds are unknown, although it is believed to have operated from the 1930s to the 1970s. In 1977, the surface area was burned with oil and straw, diced, and burned again, in an effort to decontaminate the soil.

Wastes disposed of at the Burning Grounds included ordnance materials such as black powder, smokeless powder, explosive D, Composition A-3, tetryl, TNT, and fuses. Non-ordnance materials included carbon tetrachloride, trichloroethene (TCE), paint sludges, pesticides, and various types of refuse.

2. Supplemental Field Investigation Objectives

The objectives of the supplemental field investigation include:

1) Collect sufficient data to define the extent of contamination at the two sites;

2) Collect samples that could not be collected during the original field investigation;

3) Collect sufficient samples for the completion of HHRA and BERA; and,

4) Collect samples and data required for completion of the FS.

3. Methods and Scope

The scope of the investigation at each site is described in detail in the following subsections. Each section includes a sample location map which shows the locations of previous work (samples and wells) as well as the proposed location of additional samples.

Each section also includes a table of samples and analyses. Analytical methods will be the same as those used in the previous remedial investigation (CDM Federal 1997) and are not referenced on these tables unless the analysis has not been previously performed.

The Health and Safety plan developed for the previous RI will be used for the supplemental investigation or modified as necessary to include activities that were not previously conducted. The frequency of quality assurance/quality control samples will be the same during this investigation as it was in the previous investigation.

3.1 Sample Collection Methods

Generally, sample collection and monitoring well construction methods will be the same as those listed in the RI Work Plan (CDM Federal, 1997). Two exceptions to this are subsurface soil samples and sediment samples. Additional/alternative methods that may be used during the supplemental investigation are described in the following subsections.

3.1.1 Subsurface Soil Samples

During the RI, direct push technology (DPT) was used to collect subsurface soil samples. This method involves the use of a truck-mounted rig, however, some of the proposed sampling locations in this Supplemental Field Investigation Plan are in areas with difficult access. These include areas of heavy brush and areas that are potentially wet, or where near surface soils are saturated. In order to avoid unnecessary destruction of potential wetlands, or time-consuming brush clearing operations, a stainless steel hand auger will be used to collect subsurface soils in these areas. A truck mounted DPT rig will be used in all other locations. Boreholes resulting from subsurface soil sampling activities will be sealed with hydrated bentonite powder or pellets. The standard operating procedure for DPT sample collection is presented in Attachment 1.

3.1.2 Sediment Sampling

Some of the sediment samples proposed for the supplemental investigation are located in areas with greater than 6 inches of standing water. Those samples will be collected with a stainless steel petite ("mini") ponar dredge or equivalent.

3.2 Decontamination Procedures

Decontamination methods will be the same as those listed in the RI Work Plan (CDM Federal, 1997). The handauger and ponar dredge will be decontaminated in the same manner as other stainless steel sampling equipment (bowls and spoons).

3.3 Site 2 Landfill B

During the RI, BERA, and HHRA some data gaps were identified for Landfill B. Additionally, the data were reviewed by the project engineer to identify data needs for the feasibility study. The preliminary findings of the remedial investigation at Landfill B are summarized on Table 3-1. (See Section 1.0 for summary of Landfill B historical usage.)

The proposed supplemental investigation activities and rationale are described below. The locations of the proposed additional sampling are shown on Figure 3-1.

3.3.1 Subsurface Soil

The subsurface soil at six locations around the perimeter of Landfill B will be collected for delineation of the landfill. All borings will be performed with a DPT rig and a 4-ft long Macro Core sampling devise or equivalent. The borings will extend to the water table, typically 3 to 5 ft below ground surface (bgs). If field evidence (e.g., high screening readings on a photoionization detector) indicates possible contamination, or if layers of waste are identified, a sample will be collected from that material. If there is no visual or other field evidence of waste material, a sample will be collected from a depth interval from 2 feet above the water table to the water table.

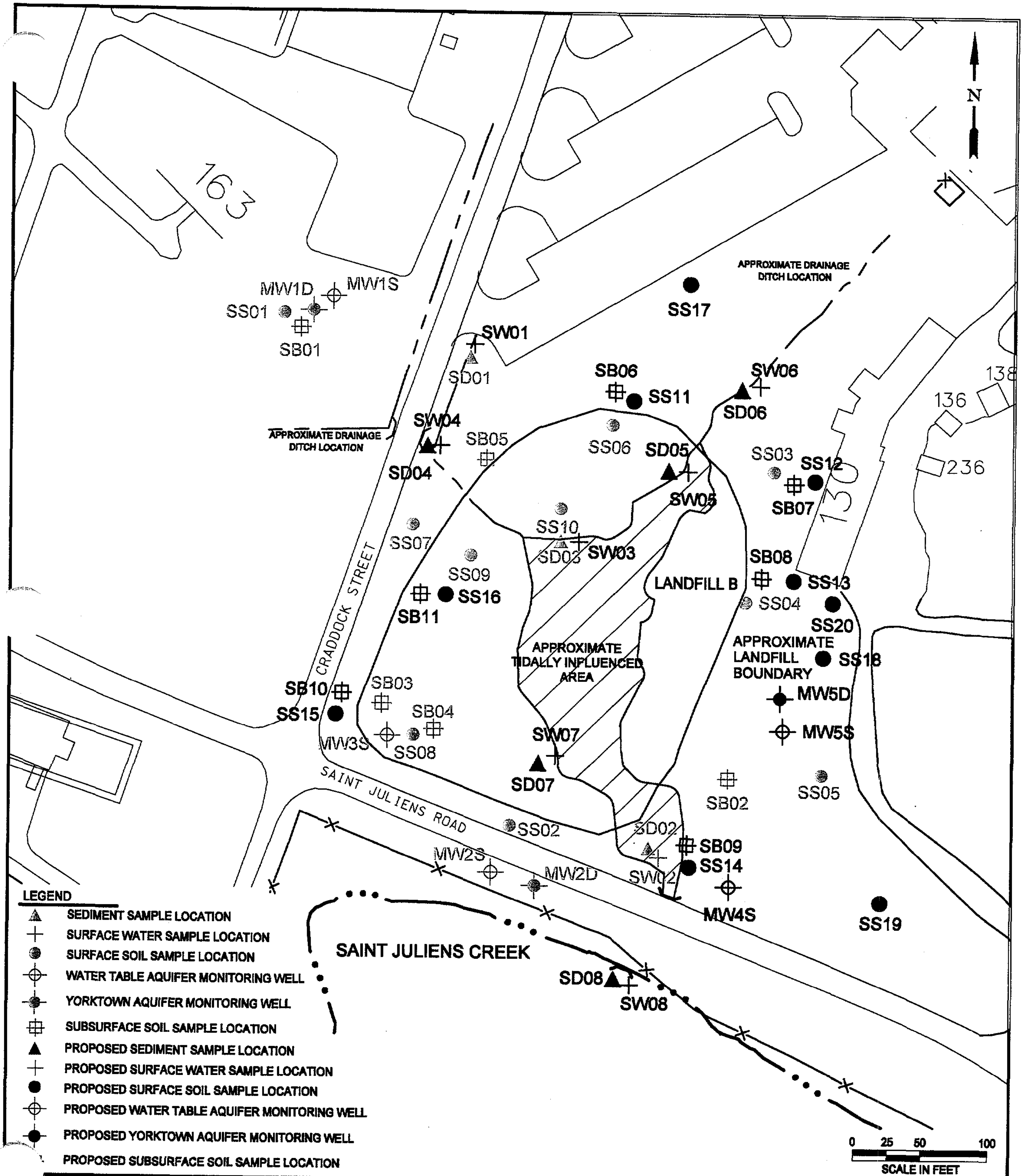
One boring (SB06) will be located near SS06 on the north side of the landfill, another (SB07) will be located near SS03 northeast of the landfill, and a third (SB08) will be located near SS04 on the northeast side of the landfill. Elevated concentrations of metals were detected in surface soil samples from these locations. In addition, SB10 will be located off the southwest corner of the landfill, west of MW03 where waste material was encountered. Sample SB09 will be located near the southeast corner of the landfill and SB11 will be located on the west side of the landfill.

3.3.2 Surface Soil

A surface soil sample will be collected at each subsurface boring location to delineate the extent of surface soil contamination (SS11 through SS16). Four additional surface soil samples will also be collected: SS17 will be located approximately 150 ft north of the landfill to confirm extent to the north, and samples SS18 and SS20 will be located north of SS05 to confirm extent to the east. Sample SS019 will be collected approximately 150 ft southeast of SS05 to confirm the extent of contamination in that direction. Surface soil samples will be collected from depths of 0.0-6.0 inches bgs.

TABLE 3-1
LANDFILL B PRELIMINARY RESULTS

MEDIA/ ACTIVITY	OBJECTIVE	OPERATIONS	ANALYTE GROUP	PRELIMINARY RESULTS
Geophysical Survey	Determine the boundaries of the landfill.	Conducted EM31 and cesium magnetometer survey on a 100′ grid where possible and along several transects.	Not Applicable	Possible area of fill identified in the northeast part of the site. Poor correlation between EM and magnetometer survey results possibly due to high salt content of soil and shallow groundwater. No clear identification of landfill boundaries.
Surface Soil	Identify type and extent of surface soil contamination	Collected 10 surface soil samples (0 to 0.25 ft). Samples screened with TNT immunoassay test kit.	TCL/TAL metals Total phosphorus One sample selected for nitramine analysis.	COPCs include metals, one PCB, pesticides, one VOC and SVOCs. Extent of organic COPCs is the known landfill area. Several samples contained elevated metals concentrations, however the concentration of naturally occurring metals is not known.
Subsurface Soil	Identify nature and extent of waste.	Collected 5 subsurface soil samples from various depths between 2 and 6 ft. from areas adjacent to the landfill boundaries. One composite from 0 to 3 ft collected for BERA. Samples screened with TNT immunoassay test kit.	TCL/TAL metals Total phosphorus. One sample selected for nitramine analysis.	COPCs include metals, and one SVOC. The concentration of naturally occurring metals is not known. Fill was encountered in boring (SB03) located in the southwest corner of the landfill. Insufficient samples collected for BERA.
Groundwater	Determine direction of groundwater flow. Identify nature and extent of groundwater contamination.	Installed 2 Yorktown Aquifer monitoring wells and 3 shallow monitoring wells. Collected two rounds of samples.	TCL/TAL metals (filtered and unfiltered) Total phosphorus. One sample selected for nitramine analysis.	COPCs include chloroform (deep aquifer only), and metals. Direction of groundwater flow has not been determined due to locations of wells. Background concentrations of metals have not been established.
Surface Water	Determine nature and extent of contamination in surface water.	Due to dry weather conditions, only one surface water sample (from the landfill pond) was collected.	TCL/TAL metals TOC Total Phosphorus Nitramine	COPCs include metals and phosphorous. The nature and extent of contamination in surface water at the site has not been determined, because most of the samples could not be collected. Background concentrations of metals are unknown.
Sediment	Determine nature and extent of contamination in sediment.	Collected 3 sediment samples.	TCL/TAL metals Total Phosphorus TOC, Nitramine	COPCs include metals, phosphorous, pesticides, PCBs, and SVOCs. Background concentrations of metals are unknown. Organics attributed to drainage ditch runoff.



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EXISTING AND PROPOSED SAMPLING LOCATIONS, SITE 2
SAINT JULIENS CREEK ANNEX

FIGURE 3-1

3.3.3 Groundwater

The data collected during the RI indicates that there may not be monitoring wells (either deep or shallow) located downgradient of Landfill B. One shallow/deep monitoring well pair and an additional shallow well will be installed. These wells are described below and the locations are shown on Figure 3-1.

Monitoring well pair MW05S/5D will be located east of the site. This location should be downgradient for the Yorktown Aquifer and will provide information to determine the downgradient direction in the water table aquifer. The shallow well will be located south (potentially downgradient) of surface soil sample SS03, which contained elevated concentrations of metals.

Shallow monitoring well MW04S is located to the southeast of the landfill and fills the gap between existing shallow monitoring wells MW02S and MW05S.

All newly installed monitoring wells will be given a minimum of 24 hours between well construction and well development.

All monitoring wells at the site will be sampled during groundwater sampling activities.

3.3.4 Surface Water and Sediment

3.3.4.1 Surface Water

At Landfill B, surface water from SW01 could not be collected during the original field effort due to dry weather conditions. Therefore this surface water sample will be collected during the supplemental investigation if surface water is available. Additionally, surface water samples will be collected at the five new sediment sample locations described in Section 3.3.4.2 (if surface water is available).

Analysis of the surface water for salinity will be included for the ecological risk assessment. The salinity will be measured with a field instrument such as a Horiba U-10 Water Quality Meter or equivalent.

3.3.4.2 Sediment

To further delineate the extent of sediment contamination five sediment samples will be collected from the locations shown on Figure 3-1. Sample SD04 will be located in the drainage ditch at a point before flow enters the ponded area. Sample SD05 will be collected from the northeast most part the pond and sample SD07 will be located in the southern end of the pond. Sample SD06 will be collected from the northeast extension of the pond in an area considered to be outside the landfill boundary. Sample SD08 will be collected from the discharge end of a culvert pipe which directs water from Landfill B into St. Juliens Creek.

3.3.5 Sample Analyses

The sampling and analysis strategy for Landfill B is summarized in Table 3-2.

3.4 Site 5 Burning Grounds

The RI concluded that the extent of contamination at this site has not been determined to the north, south and east. The majority of the supplemental samples will be collected in order to define extent. Additionally, supplemental data are required by the BERA and HHRA. Preliminary findings of the remedial investigation at the Burning Grounds are summarized on Table 3-3. (See Section 1.0 for summary of Burning Grounds historical usage.)

The proposed supplemental investigation activities and rationale are described below. The locations of the samples to be collected at the Burning Grounds are shown on Figure 3-2.

3.4.1 Subsurface Soil

The subsurface soil at six locations on the east side of the site (SB16 through SB21) will be collected to delineate the extent of contamination. Borings will be performed with a DPT rig and a 4-ft long Macro Core sampling devise or equivalent, or a stainless steel handauger. The handauger will be used at those locations not easily accessible with a DPT rig due to near-surface water and/or heavy brush. The borings will extend to the water table or 5 ft, which ever is deeper. Although the water table is typically found at depths of 3 to 5 ft bgs at the site, it is expected to be shallower at those boring locations on the eastern side of the burning grounds. In that area, the water table may be within 2 ft of the ground surface. If field evidence (e.g., high screening readings on a photoionization detector) indicates possible contamination, or if layers of ash are identified, a sample will be collected from that material. If there is no visual or other field evidence of waste material, a sample will be collected from a depth interval from 2 ft above the water table to the water table. If the water table is within 3 ft of land surface, a sample will be collected from a depth of 1 to 3 ft bgs. The standard operating procedure for DPT sample collection is presented in Attachment 1.

3.4.2 Surface Soil

A surface soil sample will be collected at each subsurface soil sample location. Surface soil samples will be collected from depths of 0.0 to 6.0 inches bgs. If the soil boring is drilled through the gravel cover that is found over some parts of the site, the surface soil sample will be collected from the top 6 inches of the native soil.

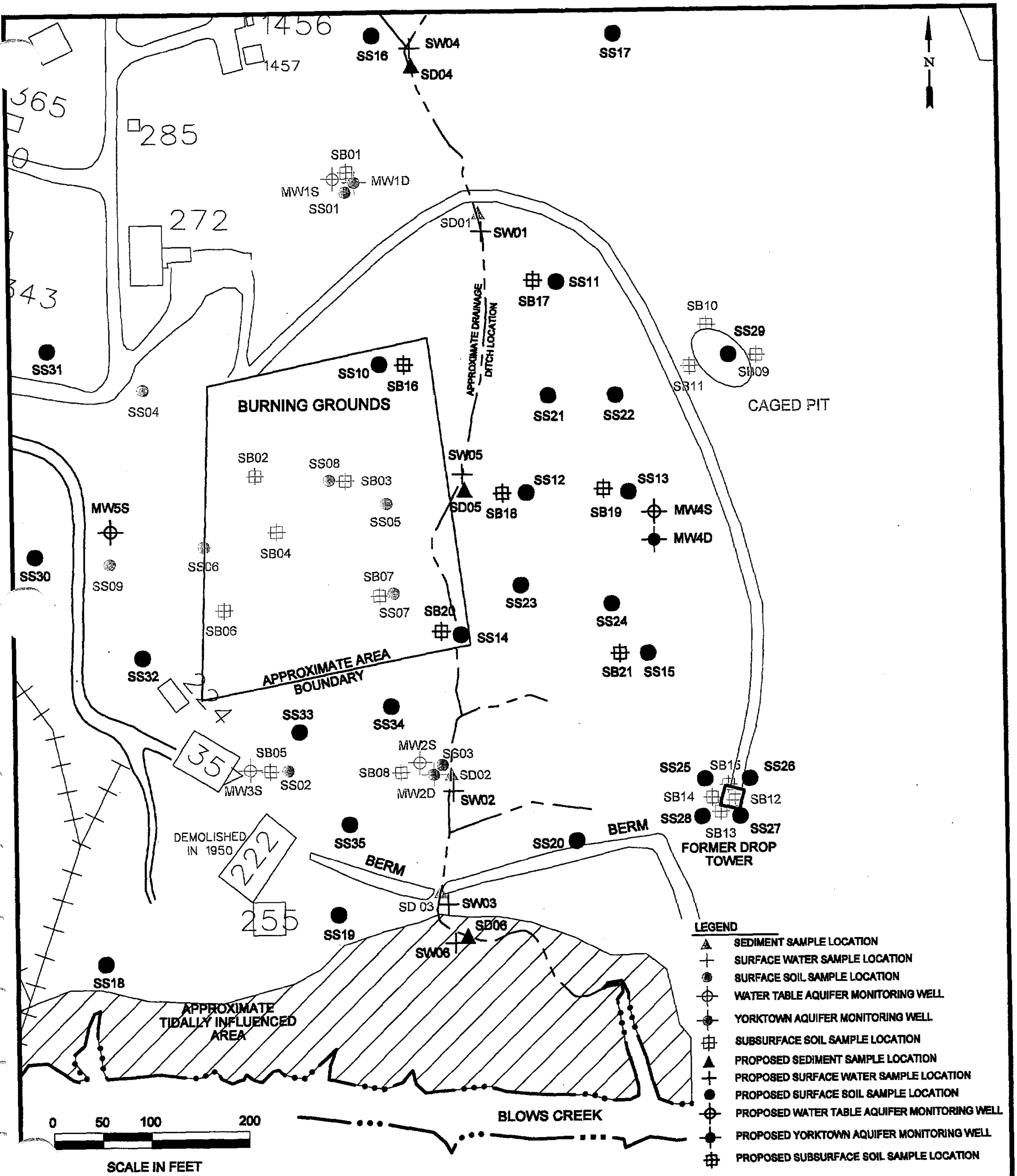
One subsurface soil sample collected during the RI at the former drop tower contained PAHs. During the supplemental investigation, four surface soil samples will be collected around the former drop tower.

TABLE 3-2
LANDFILL B SAMPLING AND ANALYSIS STRATEGY

MEDIA/ ACTIVITY	OBJECTIVE	NUMBER OF SAMPLES	ANALYTE GROUP	SAMPLING AND ANALYSIS RATIONALE
Surface Soil	Further delineation of extent of contamination.	10	TCL/TAL metals Pesticides PCBs Explosives	Contamination was defined on the landfill surface. The proposed locations are to the north and east of the landfill, beyond the areas where surface soil contamination was identified during the previous investigation.
Subsurface Soil	Confirm lateral extent of waste in southwest corner of landfill	6	TCL/TAL metals Explosives	Sample locations are at perimeter of landfill. One boring located to determine extent of fill to the southwest.
Groundwater	Install groundwater monitoring wells in both aquifers downgradient of the landfill.	8	TCL/TAL metals (filtered and unfiltered) Low level VOC Explosives	Locations of proposed Yorktown and Water Table Aquifer monitoring wells are to the east of the landfill. No monitoring wells were previously installed in this area. Shallow wells in this area will allow the determination of the direction of flow. Based on previous data, the direction of flow in the Yorktown Aquifer is suspected to be to the east. The proposed well will confirm this and allow sampling of groundwater downgradient of the landfill.
Surface Water	Collect surface water at locations that were dry during previous sampling events, as well as at new sediment sampling locations	5	TCL/TAL metals (unfiltered) Total phosphorus Low level VOC Explosives	Only one sample has been collected due to dry conditions. Proposed locations include drainage features leading to the central pond, as well as the pond. Paired with sediment sampling locations.
Sediment	Further delineate extent of sediment contamination.	4	TCL/TAL metals Pesticides PBCs Total phosphorus Explosives	Proposed locations include drainage features leading to the central pond, the pond, and at the discharge culvert in St. Juliens Creek.

TABLE 3-3
BURNING GROUNDS PRELIMINARY RESULTS

MEDIA/ ACTIVITY	OBJECTIVE	OPERATIONS	ANALYTE GROUP	PRELIMINARY RESULTS
Geophysical Survey	Determine the location of the caged pit. Determine burning ground boundaries.	Conducted EM31 and cesium magnetometer survey on grid with 50′ spacing in Burning Grounds. In the caged pit area, used a 10′ spacing.	Not Applicable	Located the caged pit. Could not delineate the Burning Ground boundaries.
Surface Soil	Identify type and extent of surface soil contamination	Collected 9 surface soil samples (0 to 0.25 ft). Samples screened with TNT immunoassay test kit.	TCL/TAL metals Total phosphorus One sample selected for nitramine analysis.	COPCs include metals, phosphorous, pesticides, VOCs and SVOCs. The concentration of naturally occurring metals is not known. Extent of contamination at the Burning Grounds has not been determined to the north, east, or south.
Subsurface Soil	Identify nature and extent of waste.	Collected 8 subsurface soil samples from the Burning Ground area, 3 from the caged pit area and 4 from the drop tower area. All collected from various depths between 2 and 6 ft. One composite sample collected for BERA from 0 to 3 ft. Samples screened with TNT immunoassay test kit.	TCL/TAL metals Total phosphorus. One sample selected for nitramine analysis.	COPCs include metals, one VOC, and one SVOC. Concentrations of COPCs decreases with depth. The concentration of naturally occurring metals is not known. No indication that caged pit activity resulted in soil contamination (no organics detected). One PAH detected in sample from former drop tower area. Insufficient samples collected for BERA.
Groundwater	Determine direction of groundwater flow. Identify nature and extent of groundwater contamination.	Installed 2 Yorktown Aquifer monitoring wells and 3 shallow monitoring wells. Collected two rounds of samples.	TCL/TAL metals (filtered and unfiltered) Total phosphorus. One sample selected for nitramine analysis.	COPCs include chloroform (deep aquifer only), and metals. Direction of groundwater flow has been determined due to locations of wells. Background concentrations of metals have not been established.
Surface Water	Determine nature and extent of contamination in surface water.	Due to dry weather conditions, no samples were collected.	None	The nature and extent of surface water contamination has not been determined.
Sediment	Determine nature and extent of contamination in sediment.	Collected 3 sediment samples.	TCL/TAL metals Total Phosphorus TOC, Nitramine	COPCs include metals, phosphorus, pesticides, VOCs and SVOCs. Background concentrations of metals are unknown. Generally, COPCs decrease in concentration downstream.



CDM Federal Programs Corporation *A Subsidiary of Camp Dresser & McKee Inc.*	EXISTING AND PROPOSED SAMPLING LOCATIONS, SITE 5 SAINT JULIENS CREEK ANNEX	FIGURE 3-2

Fifteen other surface soil samples will be collected around the burning ground area in order to define extent. These include two samples north of the SS01, six between the site and Blows Creek, four to the east of the Burning Grounds area, and three to the west and northwest.

One surface soil sample will be collected directly over the geophysical anomaly that defines the caged pit.

3.4.3 Groundwater

The RI investigation results indicated that the direction of groundwater flow in the water table aquifer is to the east-southeast. In addition, the shallow monitoring well that was thought to be upgradient of the site (MW01S) is located adjacent to an area of high surface soil contamination. During the supplemental investigation one shallow well will be installed east (downgradient) of the site, and a second will be installed to the west (upgradient) of the site. One Yorktown Aquifer well will be installed at the downgradient location (east of the site) to more accurately determine the direction of groundwater flow in that aquifer and to verify that water quality in the Yorktown Aquifer is monitored downgradient of the site.

One monitoring well pair (shallow and deep), MW04S/4D, will be located to the east of the site (this should be downgradient for both aquifers).

One shallow monitoring well, MW05S, will be located upgradient (to the west) of the site.

All newly installed monitoring wells will be given a minimum of 24 hours between well construction and well development. All monitoring wells (previously and newly installed) at the site will be sampled during the sampling event.

3.4.4 Surface Water and Sediment

3.4.4.1 Surface Water

At the Burning Grounds, surface water samples scheduled to be collected from SW01, SW02, and SW03 during the original field effort, could not be collected due to dry weather conditions. Therefore these surface water samples will be collected during the supplemental field investigation. Additionally, surface water samples will be collected at the three new sediment sample locations described in Section 3.4.4.2.

Analysis of the surface water for salinity will be included for the ecological risk assessment. The salinity will be measured with a field instrument such as a Horiba U-10 Water Quality Meter or equivalent.

3.4.4.2 Sediment

The RI data indicated that concentrations of inorganic COPCs are elevated in site sediments. All three sediment samples (from the previous investigation) were collected from a drainage ditch east of the site. The northernmost sample was collected just north of a low-lying area. The southern two samples were collected from a ditch that exits the low-lying area. It is unclear whether the ditch runs through the low-lying area or starts again south of the low-lying area.

In general, the concentrations of COPCs decrease to the south, i.e., they are highest in SD01. In order to further delineate the extent of sediment contamination to the north of SD01 one sediment sample will be collected approximately 150 ft upstream of that sample. A second sediment sample will be collected from the ditch (if it exists) approximately midway through the low-lying area and a third sediment sample will be collected downgradient of a berm located south of the site in the tidally influenced area of Blows Creek. The locations of the sediment samples are shown on Figure 3-2.

3.4.5 Sample Analyses

The sampling and analysis strategy for the Burning Grounds is summarized in Table 3-4.

3.5 Hydrogeological Investigations

3.5.1 Water Level Measurements

A full round of water level measurements will be collected during the groundwater sampling events. Water levels in all the Yorktown Aquifer monitoring wells will be collected within a 2-hour period (or less) in order to minimize the effects of the tides.

In addition, water levels in each well will be collected at high and low tide, taking into account the estimated time lag. The time lags may be different for each aquifer.

3.5.2 Aquifer Testing

Hydraulic conductivity testing of all monitoring wells that are screened in the water table or Yorktown Aquifers will be conducted. Monitoring well GW02S has been found to recover extremely slowly (over several days), and will not be tested. Hydraulic conductivity will be tested using a PVC slug, with data recorded on a data logger. The standard operating procedure for the hydraulic conductivity test is presented in Attachment 2.

The supplemental investigation will also include an investigation of tidal effects on the groundwater flow direction in both aquifers. Water levels in four Yorktown/water table aquifer monitoring well pairs at the Base will be measured over a 48-hour period using an electronic data recorder.

After well development all wells will be allowed to recover at least 12 hours prior to slug testing or the tidal study. Additionally, all wells will be allowed to recover at least 12 hours between the slug test and the tidal study. These time intervals may be increased if experience with newly installed wells indicates that more time is needed to recover.

TABLE 3-4
BURNING GROUNDS SAMPLING AND ANALYSIS STRATEGY

MEDIA/ ACTIVITY	OBJECTIVE	NUMBER OF SAMPLES	ANALYTE GROUP	SAMPLING AND ANALYSIS RATIONALE
Surface Soil	Define extent of surface soil contamination.	23	TCL/TAL metals Total Phosphorus Explosives	Four samples located in the former drop tower area where PAH was detected in subsurface soil. One sample located in caged pit area to confirm no contamination in that area. Eighteen samples located to determine extent of surface soil contamination to the west, north, south and east.
Subsurface Soil	Delineate extent of subsurface contamination to the east and northeast.	6	TCL/TAL metals Explosives	Borings also located to determine extent of fill to the east and northeast.
Groundwater	Install shallow monitoring well upgradient of Burning Grounds. Install a shallow and deep monitoring well more directly downgradient of the site.	8	TCL/TAL metals (filtered and unfiltered) Low level VOC Explosives	The direction of groundwater flow in the shallow aquifer, determined during the previous investigation indicated that no shallow monitoring wells were installed upgradient of the site. One shallow well will be installed west (upgradient) of the site and one will be installed east (downgradient) of the site. A Yorktown Aquifer well will also be installed east of the site to help confirm the groundwater flow direction and monitor the aquifer downgradient of the site.
Surface Water	Determine nature and extent of contamination in surface water.	6	TCL/TAL metals (unfiltered) Low level VOC Salinity (field measurement) Total Phosphorus Explosives	No previous samples have been collected due to dry conditions. Locations selected in drainage feature, paired with sediment sampling locations.
Sediment	Determine nature and extent of contamination in sediment.	3	TCL/TAL metals Total Phosphorus Explosives	Located to determine the upstream extent of contamination in sediments, as well as possible contamination south of the berm.

ATTACHMENT 1

STANDARD OPERATING PROCEDURES

DIRECT PUSH TECHNOLOGY (DPT)

STANDARD OPERATING PROCEDURE

Geoprobe® Soil Sample Collection

I. Purpose

To provide a general guideline for the collection of soil samples using Geoprobe® sampling methods.

II. Scope

Standard Geoprobe® soil sampling methods.

III. Equipment and Materials

- Truck-mounted hydraulic percussion hammer.
- Geoprobe® sampling rods
- Geoprobe® sampling tubes and acetate liners (if desired)
- Pre-cleaned sample containers and stainless-steel sampling implements
- Clean latex or surgical gloves.

IV. Procedures and Guidelines

1. Decontaminate sampling tubes and other non-dedicated downhole equipment in accordance with SOP Decontamination of Personnel and Equipment.
2. Drive sampling tube to the desired sampling depth using the truck-mounted hydraulic percussion hammer. If soil above the desired depth is not to be sampled, first drive the lead rod, without a sampling tube, to the top of the desired depth.
3. Remove the rods and sampling tube from the borehole and remove the sample from the tube.
4. Fill all sample containers, beginning with the containers for VOC analysis, using a decontaminated or dedicated sampling implement.
5. Decontaminate all non-dedicated downhole equipment (rods, sampling tubes, etc.) in accordance with SOP Decontamination of Personnel and Equipment.
6. Backfill borehole at each sampling location with grout or bentonite and repair the surface with like material (bentonite, asphalt patch, concrete, etc.), as required.

V. Key Checks and Items

1. Verify that the hydraulic percussion hammer is clean and in proper working order.

2. Ensure that the Geoprobe® operator thoroughly completes the decontamination process between sampling locations.

3. Verify that the borehole made during sampling activities has been properly backfilled.

ATTACHMENT 2

STANDARD OPERATING PROCEDURES

HYDRAULIC CONDUCTIVITY TESTING

STANDARD OPERATING PROCEDURE

Aquifer Slug Testing

I. Purpose and Scope

The objective of this procedure is to define the requirements for conducting and analyzing in-situ hydraulic conductivity (slug) tests in small, developed wells.

II. Equipment and Materials

The following equipment should be utilized when performing a rising or falling head slug test in a monitoring well. Site specific conditions may warrant the use of additional equipment.

- Pressure transducer and data recorder, if data is to be automatically recorded, and manufacturers instructions
- Personal computer for downloading data and optionally, a field printer
- Water-level measuring device
- Stopwatch, if needed
- Slug device of know volume
- Rope or wire
- Duct tape
- Bailer
- Field Logbook
- Decontamination equipment and supplies
- Data on the construction of the well (depth to screen, screen length, well drilled diameter, riser diameter, height of sandpack above screen and length of riser above ground surface).

The slug bar may be constructed of solid plastic, such as PVC, or metal such as aluminum or steel (depending upon the chemical environment in the well). The slug bar should be of sufficient size to cause a minimum of two feet of displacement in a well. For a two-inch diameter monitoring well, the slug bar should be no more than 1.5 inches in diameter and a minimum of 5 feet long. For a four-inch diameter well, the slug bar should be no more than 3 inches in diameter and a minimum of 5 feet long. The slug bar should be securely fastened to a nylon rope or braided metal wire.

A standard sampling or well development bailer may be used in place of the slug bar, as long as the volume of water displaced by the bailer is sufficient to change the water level in the well a minimum of two feet. If the bailer is to be used for a falling head test, it should be filled with analyte-free water so that the bailer will not have any buoyancy.

III. Procedures and Guidelines

The following steps must be followed when preparing for slug testing:

1. Lay plastic sheeting around the wellhead. Arrange needed equipment and decontamination materials on the sheet.
2. Put on personnel protective clothing, as specified in the site-specific health and safety plan.
3. Open the protective casing locking lid and vented riser caps following the procedures outlined in SOP 1-6. Note the physical condition of the well, including damage, deterioration and signs of tampering. Note any unusual odors, sounds, or difficulties in opening the well. Record organic vapor readings with a suitable organic vapor screening device.
4. Measure and record the static water level, the depth to the bottom of the well and inside diameter of the well casing. Record these data in the appropriate logbook.
5. If using a pressure transducer and data logger, lower the pressure transducer into the well to a sufficient depth so that the transducer will be below the maximum depth reached by the bottom of the slug bar or other displacement device. If necessary, calibrate the transducer as specified by the manufacturer. Allow the transducer to temperature equilibrate in the well for approximately 15 minutes after insertion and prior to any calibration or test procedure to ensure that it will accurately record water level changes. Make sure that the transducer is not placed below its maximum operating depth, or it will not be able to detect any change in pressure. For example, pressure increases 1 pound per square inch (psi) per 2.3 feet of head; therefore, a 10 psi transducer will function to a depth of 23 feet below the water level in the well.
6. Secure the pressure transducer cable to the well riser or casing using duct tape. The transducer cable should lie flat along side the well riser, so that disturbance by the slug bar will be minimized. Do not kink the transducer cable, otherwise the pressure equalization vent tube in the cable will be damaged and the transducer will not function properly.
7. Allow the water level in the well to recover to static after emplacement of the pressure transducer, prior to starting the test. Measure and record this water level.
8. If using a data logger, program the data logger to record logarithmically, with a maximum time interval of no more than 1 minute between readings. If the formation is expected to have low hydraulic conductivity, the maximum interval

between readings can be set to a longer time interval, such as 10 minutes. Set the data logger to record relative change in head, not absolute head.

9. Determine the distance from the top of the well riser to the water surface in the well and add one foot to this length. The resulting length is the amount of wire or rope needed so that the slug bar or bailer will be submerged a minimum of one foot when it is placed in the well. A loop should be placed in the rope or wire at this length and a strong metal rod or wooden stick placed and secured through the loop. If the bottom of the well is less than this length added to the length of the slug bar or bailer, the length of the rope or wire should be adjusted so that the slug bar will be no less than one foot above the top of the pressure transducer when the bar is inserted into the well.

10. If depth readings are to be recorded manually (this procedure is recommended only in formations suspected of having low hydraulic conductivity, less than 5 feet per day), readings should be taken every 10 seconds for the first minute of the test, every 30 seconds for the next 4 minutes and every minute until 10 minutes. Thereafter, readings should be taken every 5 minutes for the duration of the test. If the well has not recovered within one hour, readings should be taken every 0.5 hours until six hours and one hour every hour thereafter. This process will require two personnel during the first ten minutes of the test: one to act as time keeper/data recorder and one to measure depth to water in the well.

<u>Falling-Head Slug Test Procedure</u>:

This test can only be conducted in wells whose screens are fully submerged, otherwise, displaced water will be introduced into the unsaturated zone and recovery rates will be due to flow in both the unsaturated and saturated zones. All slug test analytical procedures assume flow in the saturated zone only. The following steps must be followed when performing falling-head slug tests:

1. Place the slug or bailer in the well until the bottom of the displacement device is no more than 6 inches to 1 foot above the water level in the well. The person holding the device should be holding the rope or wire by the rod or stick.

2. Switch on the data recorder, or set the water level meter probe near the level at which water is expected to rise.

3. To start the test, the person holding the slug bar will signal the person operating the data logger or water level indicator, then rapidly lower the displacement device into the well until the stick or rod is resting horizontally on top of the well riser. The slug bar should not be dropped, in order to minimize sloshing in the well. The data logger is turned on or manual measurements commenced at the moment the slug bar is lowered.

4. Continue recording depth-time data until the well has recovered to at least 90 percent of the static water level. When using data recorders, it is advisable to check and record the reading every few minutes to ensure that data are being properly recorded. If 90 percent recovery has not occurred within 12 hours, the test may be stopped. Field conditions and time constraints may warrant stopping

the test in less than 12 hours. The final decisions under these circumstances will be the responsibility of the field team leader.

5. Record the time of test completion in the logbook. If a data recorder with random access memory (RAM) or erasable programmable read only memory (EPROM) was used, record the file name used.

6. Decontaminate all equipment. Clean up the site, and close and lock the well before leaving. Contaminated plastic sheeting and disposable protective clothing should be taken to designated disposal containers.

7. Download the data logger to a computer or to hard copy to ensure that the data is not inadvertently lost. If the data were recorded manually, calculate the relative change in head by subtracting the recorded depths to water during recovery from the initial static depth to water reading and record the absolute value of that change, for each depth-time data pair.

Note: Both rising- and falling-head slug tests may be carried out in the same operation by first measuring the rate of water-level fall immediately after slug insertion, then measuring the rate of water-level rise after slug withdrawal. Be sure that the well has recovered to the static water level before conducting the rising-head test. If using a data logger, the recovery tests needs to be set up and run as a separate test.

<u>Rising-Head Slug Test Procedure</u>:

The steps for a rising head test are essentially the same as those for a falling head test. In a well screened across the water table, a rising head test is the only test that is valid. The following steps must be followed when performing rising-head slug tests:

1. Lower the slug bar or bailer of known volume into the well until it is fully submerged. Allow the well to re-equilibrate to static water level. In formations of suspected low hydraulic conductivity, re-equilibration may take several hours or overnight. In such cases, it is suggested that the displacement device be placed in the well at the end of a field day and the test conducted the following day.

2. Turn on the data recorder, if used, or verify that static water level has been re-established with a water-level meter.

3. To start the test, the person holding the slug bar will signal the person operating the data logger or water level indicator, then rapidly and smoothly raise the displacement device from the well until the bottom of the slug bar is above the static water level in the well. The data logger is turned on or manual measurements commenced at the moment the slug bar is lowered. If a data logger is being used, the slug bar wire or rope should be secured to the well casing or riser for the duration of the test and only removed after the test has been completed, in order to avoid disturbing or dislocating the pressure transducer.

4. Continue recording depth-time data until the well has recovered to at least 90 percent of the static water level. When using data recorders, it is advisable to check and record the reading every few minutes to ensure that data are being properly recorded. If 90 percent recovery has not occurred within 12 hours, the test may be stopped. Field conditions and time constraints may warrant stopping the test in less than 12 hours. The final decisions under these circumstances will be the responsibility of the field team leader.

5. Record the time of test completion in the logbook. If a data recorder with random access memory (RAM) or erasable programmable read only memory (EPROM) was used, record the file name used.

6. Decontaminate all equipment. Clean up the site, and close and lock the well before leaving. Contaminated plastic sheeting and disposable protective clothing should be taken to designated disposal containers.

7. Download the data logger to a computer or to hard copy to ensure that the data is not inadvertently lost. If the data were recorded manually, calculate the relative change in head by subtracting the recorded depths to water during recovery from the initial static depth to water reading and record the absolute value of that change, for each depth-time data pair.

IV. Attachments

None.

V. Key Checks and Preventive Maintenance

Check the batteries for the datalogger and computer. Check that the computer disks containing the programs for the datalogger are packed. Include blank computer disks for file storage.

Check the datalogger calculation of the well hydraulic conductivity at the end of each test to determine if these are consistent with expectations.